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REMARKS

An Excess Claim Fee Payment Letter is submitted herewith for the cost of four (4) excess total claims.

Applicant notes that claims 9-30 have been renumbered claims 8-29 to address the Examiner's objection thereto. That is, the originally filed claims have been renumbered as claims 1-29. Where appropriate, the dependency of claims 8-29 has been amended, to correspond with the renumbering.

Claims 1-30 are all the claims presently pending in the application. Claims 9-12, 14-16, 18, 21-25, 27 and 29 have been amended to more particularly define the claimed invention. Claim 30 has been added to claim additional features of the claimed invention.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 1 and 14 stand rejected under 35 U.S.C. §102(b) as being anticipated by Chen et al. (U.S. Patent No. 5,917,749). Claims 2, 9-10, 12, 20-21 and 25-28 stand rejected under 35 U.S.C. §102(e) as being anticipated by Ikeda et al. (U.S. Patent No. 6,721,201). Claim 14 stands rejected under 35 U.S.C. §102(e) as being anticipated by Hirai et al. (U.S. Patent No. 6,703,676).

Claims 3, 5, 14-16, 22 and 24 stand rejected under 35 U.S.C. §102(e) as being anticipated by Dieny et al. (U.S. Patent App. Pub. 2005/0002228 A1). Claim 4 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Hirai et al. (U.S. Patent No. 6,703,676) in view of Pakala et al. (U.S. Patent App. Pub. 2005/0106810 A). Claims 6-7 stand rejected 35 U.S.C. §103(a) as being unpatentable over Hirai et al. in view of Iwasaki (U.S. Patent No. 6,625,058). Claim 11 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Ikeda in view of Elliot et al. (IEEE Transaction on Magnetics, Volume 38, no 5 September 2002). Claim 13 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Ikeda in view of Nakada et al. (U.S. Patent No. 6,341,053). Claim 17 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Ikeda in view of further remark. Claim 18 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Chen et al. (U.S. Patent No. 5,917,749) in view of Inomata et al. (U.S. Patent No. 6,069,820). Claim 19 stands rejected under 35 U.S.C. §103(a) as being

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unpatentable over Chen et al. in view of Deak (U.S. Patent No. 6,728,132) and in further view remark. Claim 23 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Dienty et al. in view of further remark.

These rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

Applicant notes that the features of the exemplary aspects of the claimed invention which are described in this Amendment may pertain only to those particular aspects of the claimed invention. These features are not necessarily included in other aspects of the invention and, therefore, the description of such features in this Amendment should in no way be considered as limiting other aspects of the invention which may be disclosed in the present Application or which may be the subject of other patents or patent applications.

The claimed invention, as exemplarily described by independent claim 1, is directed to a spin-current switched magnetic memory element, including a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and having a current-switchable magnetic moment, and at least one barrier layer formed adjacent to said plurality of magnetic layers.

In conventional magnetic memory elements, the threshold current is too high (e.g., by at least an order of magnitude) for successful insertion into current generation complementary metal oxide semiconductor (CMOS) circuits (Application at page 2, lines 5-8).

The claimed invention, on the other hand, includes a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and **having a current-switchable magnetic moment**. That is, unlike conventional magnetic memory elements, the claimed invention may utilize the perpendicular magnetic anisotropy component observed in some magnetic thin films to at least substantially offset (e.g., counter-balance) the strong demagnetization effect $4\pi M_s$, thus removing the main barrier for current induced magnetic reversal, and reduce the switching current threshold (Application at page 9, line 22-page 10, line 4).

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II. THE ALLEGED PRIOR ART REFERENCES

A. Chen

The Examiner alleges that Chen teaches the invention of claims 1 and 14. Applicant submits, however, that there are elements of the claimed invention that are not taught or suggested by Chen.

Specifically, Applicant respectfully submits that Chen does not teach or suggest "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

As noted above, unlike conventional magnetic memory elements, the claimed invention may utilize the perpendicular magnetic anisotropy component observed in some magnetic thin films to at least substantially offset (e.g., counter-balance) the strong demagnetization effect $4\pi M_s$, thus removing the main barrier for current induced magnetic reversal, and reduce the switching current threshold (Application at page 9, line 22-page 10, line 4).

Clearly, this feature is not taught or suggested in Chen. In fact, Chen merely discloses a magnetic memory cell having two layers of magnetic material separated by a layer of non-magnetic material (Chen at Abstract).

Indeed, Applicant points out to the Examiner that the claimed invention (e.g., claims 1 and 14) may include a "**spin-current switched magnetic memory element**". This is not the same as what was disclosed in Chen.

Instead, Chen merely discloses a low-field switched MRAM cell. These are **spin-valve type of memory structures that require the application of a magnetic field for switching**.

On the contrary, the claimed invention may include a memory element **switchable by a spin-current and not necessarily by a magnetic field**. The Examiner should understand that a "spin-valve" generally does not mean the same thing as a spin-current switched magnetic memory. Nowhere does Chen teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Chen clearly does not teach or suggest the claimed invention.

Further, Applicant would point out that the Examiner alleges that Chen discloses that

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layer 12 in Figure 3 depicts a magnetic layer having a current-switchable magnetic moment. However, nowhere does Chen teach or suggest that layer 12 has a current-switchable magnetic moment. Indeed, the Examiner has **no factual basis** for making such an allegation.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Chen. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. Ikeda

The Examiner alleges that Ikeda teaches the invention of claims 2, 9-10, 12, 20-21 and 25-28 and makes obvious the invention of claim 17. Applicant submits, however, that there are elements of the claimed invention that are not taught or suggested by Ikeda.

Specifically, like Chen, Ikeda does not teach or suggest "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28. As noted above, the claimed invention may utilize the perpendicular magnetic anisotropy component observed in some magnetic thin films to at least substantially offset (e.g., counter-balance) the strong demagnetization effect $4\pi M_s$, thus removing the main barrier for current induced magnetic reversal, and reduce the switching current threshold (Application at page 9, line 22-page 10, line 4).

Clearly, this feature is not taught or suggested in Ikeda. In fact, Ikeda merely discloses a magnetoresistive film including a non-magnetic film between two magnetic films at least one of which is a perpendicular magnetic anisotropy film (Ikeda at Abstract).

However, nowhere does Ikeda teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Ikeda clearly does not teach or suggest the claimed invention.

Further, the Examiner alleges that Ikeda discloses that layers 354, 355 in Figure 9 depict a magnetic layer having a current-switchable magnetic moment. However, nowhere does Ikeda teach or suggest that either of layers 354, 355 has a current-switchable magnetic moment. Indeed, the Examiner has **no factual basis** for making such an allegation.

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In fact, with respect to claim 2, Applicant again points out that the claimed invention may include a “spin-current switched” memory. Ikeda on the other hand, merely discloses methods of controlling thin film anisotropies for a magnetic-field switched element (see Ikeda's background discussion, col.1, line 8-11, and then explicitly in Ikeda at claim 13). This is a completely different field from the claimed invention.

Even assuming that the knowledge and methodology for inducing perpendicular magnetic anisotropy in thin films existed before the claimed invention, Applicant points out that the claimed invention may relate to a sub-class of magnetic thin films with perpendicular anisotropy that can be used to improve the characteristics of a spin-current switchable device. This is neither, disclosed, included in, suggested nor obvious from the prior art such as Ikeda

With respect to claim 9, Applicant notes that the teaching of Ikeda (e.g., Fig 9 and Abstract) is about a low-magnetic-field switchable memory element. **Ikeda does not teach or suggest the effect of spin-current.** Nor does Ikeda teach or suggest the use of spin-current to switch a magnetic element, let alone the advantages a perpendicular anisotropy materials system would have under a spin-current induced switch.

Instead, Ikeda merely relates to the conventional MRAM architecture where the magnetic switching is accomplished, one way or another, **by the application of a magnetic field** on the storage element. This is distinctively different from the claimed invention that may include a spin-current switchable memory element, in which case **the switching action does not necessarily require the application of a magnetic field.**

With respect to claim 10, Applicant notes that the magnetic tunnel junction in Ikeda's device merely serves as a read-out device. The intent of the Ikeda device, and in many conventional MRAM applications, is to read out the magnetic state of the magnetic storage element by a measurement of the resistance of the magnetic tunnel junction. In this case a current bias is used on the junction only to read-out its resistance (and hence magnetic) state, and **not to change its magnetic state.** This is materially different from the claimed invention, which may allows the use of a spin-current to switch a magnetic memory element (e.g., to change the magnetic state). Such an application of a magnetic tunnel junction is clearly not taught or suggested by Ikeda.

With respect to claim 12, Applicant notes that similar to the discussions above with

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respect to claim 10, Ikeda's teachings are about a magnetic tunnel junction used as a *read-out* device. Ikeda does not teach or suggest the use of a magnetic tunnel junction as a **spin-current write device**. Moreover, Applicant submits that **it is neither obvious nor deducible from Ikeda's teaching that such devices can be used for a spin-current-based write operation.**

With respect to claims 20-21, Applicant notes even assuming that the choice of using aluminum oxide as a tunnel barrier for magnetic tunnel junction, and general structure of a magnetic tunnel junction may be well known in the published literature, the additional possible choices of a tunnel barrier suitable for a spin-current induced switching device have not seen wide discussion in published literature at the time of the claimed invention. Indeed, the claimed invention (e.g., claims 20 and 21) is the first to suggest the applicability of these exemplary materials choices for use in a spin-current switchable magnetic tunnel device.

This is different from the application in a magnetic tunnel junction for read-out applications as taught by Ikeda. Specifically, a magnetic tunnel junction for spin-current writing may need to allow much larger amount of current to pass through the junction without junction failure. This may only be achievable in a junction with relatively low resistance (often in the range of 2 to 10 $\Omega\mu\text{m}^2$ of barrier specific-resistance). This is different from the junctions used today for magnetic RAM's read-out, which usually have barrier specific resistances larger than 100 $\Omega\mu\text{m}^2$. The junctions also may have to endure quite a large amount of voltage bias during the passage of large current, typically above 0.4 to 0.6 Volts. These may be quite stringent requirements as far as junction fabrication is concerned and may require the experimentation and adoption of new tunnel barrier materials and/or processing methods.

With respect to claim 25, as discussed above, Ikeda's disclosure pertains only to a **magnetic-field switched** magnetic memory element. The layout and circuit function of these two classes of memories are substantially different. Applicant submits that **it is not obvious that a magnetic tunnel junction used for read-out can be switched with a spin-current**. It is equally non-obvious that a spin-current switched magnetic memory element can practically be read-out using the same circuit and the same magnetic tunnel mechanism.

The device in Ikeda and the claimed invention may have a similar appearance in that they may both be "pillar-like" and they may both be composed of multilayers of magnetic thin films

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and tunnel barriers. However, the function and principles of operation of these memory cells are clearly different. The tunnel magnetoresistive device disclosed by Ikeda does not have the attribute of being a **spin-current switched device** which may be included in the claimed invention..

With respect to claim 26, the claim is about a “spin-current switched magnetic memory element”. Ikeda’s is about a magnetic-field switched magnetic tunnel junction. There are material differences in these two classes of memory element. They both can use a magnetic tunnel junction, but the tunnel junction serves different purposes and requires different device and/or materials optimization procedure. The teachings of Ikeda’s and ours are about two different types of structures with different functionality.

With respect to claim 27, again, Ikeda does not teach or suggest a spin-current switched magnetic memory element. Instead, the Ikeda device is a magnetic-field switched spin-valve or magnetic tunnel junction stack. A tunnel magnetoresistive device is not inherently a spin-switched magnetic memory, nor was it illustrated to be one in Ikeda’s patent. Because of the nature of these two-terminal devices they will always appear to be pillars and/or multilayers. However, these are not the determining attributes of the claimed invention.

For the claimed invention of claim 27 includes a “spin-current switched memory element”, and one construct of this element includes a magnetic layer with perpendicular anisotropy, whose function, among other things, may include reducing the switching current of a spin-current switched device. These are neither taught, suggested, nor deducible from Ikeda’s patent.

With respect to claim 28, the magnetic random access memory array formed by a plurality of magnetic spin-current switched memory as in the claimed invention is materially different from those disclosed by Ikeda. In Ikeda, an electric current is used to induce a magnetic field in close proximity to the said magnetic memory element. It is the magnetic field that actually couples to the memory element’s magnetic layer and switches the magnetic layer.

In the claimed invention, on the other hand, **the action of the spin-current directly passing through the memory element may accomplish the magnetic switching**. As was discussed above, this is a fundamentally different way of forming a memory cell structure.

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Further, Applicant would point out that the Ikeda device is **materially different** from the claimed invention. Indeed, the Ikeda device operates on a different principle (magnetic-field write, instead of a spin-current write, operation). Since Ikeda does not use spin-current for write operation, there is no such issue as the magnetic moment being rotated out of the film plane under a spin-current excitation. It is neither obvious nor relevant that Ikeda's disclosure could point ways to the implementation of a spin-current switched device, let alone in teaching the use of perpendicular anisotropy term to reduce the threshold current for spin-current switching.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Ikeda. Therefore, the Examiner is respectfully requested to withdraw this rejection.

C. Hirai

The Examiner alleges that Hirai teaches the invention of claim 14. Applicant submits, however, that there are elements of the claimed invention that are not taught or suggested by Hirai.

Specifically, like Chen and Ikeda, Harai does not teach or suggest "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Harai. In fact, Harai merely discloses a magnetic memory device including a non-magnetic tunnel barrier layer between upper and lower magnetic layers (Harai at Abstract).

However, nowhere does Harai teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Harai clearly does not teach or suggest the claimed invention.

Further, the Examiner alleges that Harai discloses that layers 15, 17 in Figure 1B depict a magnetic layer having a current-switchable magnetic moment. However, nowhere does Ikeda teach or suggest that either of layers 15, 17 has a current-switchable magnetic moment. Indeed, the Examiner has **no factual basis** for making such an allegation.

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Further, Applicant notes that Hirai also discloses a memory device based on **magnetic-field-based write operation**. This is obvious from Hirai's Fig.1 and the description thereafter. Specifically, elements 19 and 21 in Harai's Figure 1, and the descriptive text in column 6, lines 44-60, clearly stated the function of elements 19 and 21 as providing the **necessary magnetic field** for write operation.

That is, Harai clearly does not teach the use of a **spin-current-based memory element**, in which the magnetic write-operation is accomplished by a spin-current acting directly on the memory device and not through the application of a magnetic field.

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Hirai. Therefore, the Examiner is respectfully requested to withdraw this rejection.

D. Dieny

The Examiner alleges that Dieny teaches the invention of claims 3, 5, 14-16, 22 and 24, and makes obvious the invention of claim 23. Applicant submits, however, that there are elements of the claimed invention that are not taught or suggested by Dieny.

Specifically, Dieny does not teach or suggest "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Dieny. In fact, Dieny merely discloses a magnetic tunnel junction (MTJ) device having reference layer 36 and storage layer 38 having a magnetization perpendicular to the plane in these layers (Dieny at [00122]; Abstract).

However, nowhere does Dieny teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Dieny clearly does not teach or suggest the claimed invention.

Further, the Examiner alleges that Dieny discloses that layers 36, 38 in Figure 4 depict a magnetic layer having a current-switchable magnetic moment. However, nowhere does Dieny

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teach or suggest that either of layers 36, 38 has a current-switchable magnetic moment. Indeed, the Examiner has **no factual basis** for making such an allegation.

Further, with respect to claim 3, Applicant notes that Dieny 's Fig.3 and paragraph [0118], Fig.4 and [0122] propose to have multilayered Co-Pt (alternate layers of Co and Pt) as either the magnetically fixed layer or the magnetically switching layer with perpendicular anisotropy. This is not necessarily what the claimed invention (e.g., as in claim 3) is intended to cover.

Indeed, there are physics reasons why a stacked Co/Pt multilayer, while possessing perpendicular magnetic anisotropy, is **not necessarily useful for spin-current-induced magnetic switch**. To enable spin-current driven magnetic switch, one may need to devise a layer structure (a) with perpendicular or nearly perpendicular magnetic anisotropy, and (b) having a magnetic stack that preserves the spin-polarization of the current.

Heavy elements such as Pt, while useful in creating interface-based perpendicular magnetic anisotropy with transition metals such as cobalt, will diminish spin-polarization if it is present in the part of the stack where spin-current is suppose to transfer its spin-angular momentum to the magnetically switchable layer, making the spin-transfer process very weak, requiring large amounts of current before the effect of spin-current on magnetization becomes visible at all.

Thus, Dieny does not teach or suggest using spin-current to switch a magnetic moment. Indeed, **Dieny only proposes to use spin-current as a supplemental mechanism appendix to heating**, using the spin-current only as a way to set the magnetic orientation direction upon the cooling of the magnetic element. Dieny does not teach or suggest using spin-current in the Dieny device as the primary mechanism to switch a magnetic moment without significant amount of heating.

With respect to claim 5, 15 and 22, Applicant notes that the knowledge of multilayer structures that possess the possibility of having a perpendicular component of magnetic anisotropy may be well publicized in the magnetic materials physics literature (See, e.g., Koji Matsumoto, Fujitsu Sci. Tech. J. 37, 155 (2001), R. Skomski et al., Phys. Rev. B 58, 3223 (1998), U. Nowak et al., Phys. Rev. B 56, 8143 (1997); Naoki Nishimura et al., J. Appl. Phys.

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91, 5246 (2002), and ... Even more specifically, the materials system of epitaxial layered Cu/Ni is studied by O'Handley and company for many years, e. g: Gabriel Bochi et al., Phys. Rev. B 52, 7311 (1995), etc.).

Dieny listed some possible choices of materials combinations in their patent with the objective of controlling the coercive force of the magnetic layers, which is a very important parameter for a magnetic-field induced switching. Indeed Dieny's intention is to use a spin-polarized current to generate a magnetic field that acts on the "storage layer" so as to accomplish the write operation (e.g., see paragraph [0044] of Dieny's patent publication). This is also evident in Dieny's claim 1 which is about *"a magnetic device wherein the blocking temperature of the magnetization of the storage layer is lower than the blocking temperature of the magnetization of the reference layer and in that the device further comprises means for heating the storage layer And means for applying to said storage layer, a magnetic field capable of orientating the magnetization"* In short, Dieny's claims are about a thermally assisted write mechanism that may use magnetic materials with perpendicular anisotropy.

The claimed invention, however, may use **a component** of the perpendicular anisotropy in a spin-current-switchable device to reduce the switching current. Dieny's claimed device, on the other hand, **requires heating**. The claimed invention does not necessarily require this. Dieny's claimed device requires **application of magnetic field**. The claimed invention does not. In short, the claimed invention (e.g., claim 5) is for a different device and implementation than the Dieny device.

Further, with respect to claim 14, Dieny's disclosure is primarily based on a magnetic-field write operation, as is made apparent by Dieny's elements 22 and 26 in Figure 1, Figure 7, Figure 10 and Figure 11, together with the accompanying text in [0077] through [0079], [0097]-[0101], [0104]. Dieny does disclose a method of using spin-current for the switching of their memory element [0083][0142], but this is described in combination with a junction-heating operation [0109], [0135], [0139]. The spin-torque is only taught as a possible alternative mechanism for setting the magnetic orientation of the memory device when it is cooled from its heated state. Dieny does not teach or suggest the use of a spin-current as the primary switching mechanism **without the assistance of either heating or a magnetic field**. One reason behind this is because to accomplish a magnetic reversal using spin-current, the magnitude of current

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required is usually too large to be practical.

This is exactly the problem our patent aims to solve. In our claims, the structure may appear similar to Dieny's. Indeed it is actually simpler than theirs, but the write action is accomplished by spin-current alone, without the assistance of heating or magnetic field. Claim 14 is the generic structure for one implementation of such a spin-current switched magnetic element, and it is by nature different from those taught by Dieny

With respect to claim 24, Applicant submits that the sequence of layers as disclosed in our Claim 24, (as illustrated in Fig. 2A, B, and Fig.4, is different from the teachings of Dieny Here we specifically claim the ferromagnetic layers face each other across a barrier layer, and the heavier metal layers, the Pt, Au, and Cu layers for example, are on the opposite side of the ferromagnetic layer, away from the barrier separation layer. This is such that the heavy metal layers such as Pt do not destroy the spin-polarization of current that is passing through the magnetic layer used for switching.

With respect to claim 23, as noted above, Dieny's device is primarily a magnetic field switched device, or a device switched using a combination of heating and magnetic field and/or spin-current. The structure of the device proposed in Fig. 3 of Dieny's publication explicitly highlighted the function of the magnetic field (element 34). As to Fig. 4 of the same publication, it describes a junction stack with magnetic layers having a moment oriented perpendicular to the film surface (see drawing as well as description [0122].

Further, paragraph [0123]-[0125], as well as Fig. 5 state that their structure is used to tune the coercive force of the magnetic layers – an important parameter for magnetic field switching, as well as the temperature dependence of that coercivity, a parameter important to control for a thermally assisted switch. Therefore, the Dieny device is structured for use with a combination of magnetic field and heating action for selective write. It does not follow naturally from the Dieny disclosure that one could use, let alone optimize, their kind of stack structure for a spin-current driven magnetic switch as related to the claimed invention (e.g., claim 23).

Therefore, Applicant submits that there are elements of the claimed invention that are not taught or suggested by Dieny. Therefore, the Examiner is respectfully requested to withdraw this rejection.

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E. Pakala

The Examiner alleges that Hirai would have been combined with Pakala to form the invention of claim 4. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicant respectfully submits that these references are unrelated and would not have been combined as alleged by the Examiner. Thus, no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that there is no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, these references clearly do not teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, neither Harai, nor Pakala, nor any combination thereof teaches or suggests "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Pakala. In fact, nowhere does Pakala teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Pakala clearly does not teach or suggest the claimed invention.

Further, with respect to claim 4, the rejection of claim 4 in the present Application is based on its fundamental similarity to the invention of Hirai et al, and that of Pakala

As discussed above, Hirai's invention is for a different class of structures, relying on magnetic field-induced switching for write-operation. Harai's switching magnetic field has to be generated by passing a current adjacent to the magnetic memory element. Harai's structure elements 19 and 21 in Fig.1 A, B and elsewhere are specifically designed for this purpose – to introduce a magnetic field required for the device to switch. This mechanism is also evident from the description in column 6, lines 45-50 and lines 54-60.

The claimed invention may use a write-operation which uses a spin-current passing

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directly through the magnetic storage layer, causing it to switch magnetically. Therefore, the claimed device structure is not taught or suggested by that of Harai or Pakala.

As to the teachings of Pakala, the Examiner is reminded that the general understanding that a strong, shape-determined easy-plane anisotropy is the cause of a large switching threshold current does not originate from Pakala. It was understood in the works of John Slonczewski (J. Magn. Magn. Mat. 159, L1, (1996), of J. Z. Sun, J. Magn. Magn. Mater. 202, 157 (1999), of J. A. Katine et al: Phys. Rev. Lett. 84, 3149 (2000), and was discussed in detail in the paper of the inventor herein: J. Z. Sun, Phys. Rev. B62, 570 (2000).

The concept that this undesirable presence of the easy-plane anisotropy can be neutralized by other forms of anisotropy does not originate from Pakala et. al, either. In fact this is an assumption for some calculations discussed in my paper mentioned above (J. Z. Sun, Phys. Rev. B62, 570 (2000); see discussions preceding Eqn.29).

Further, the knowledge that a cobalt/gold interface can generate perpendicular magnetic anisotropy does not originate from Pakala et. al, either. It was in fact discussed quite often in the open literature, prior to Hirai's claims. See, for example, Akihiro Murayama et al. Phys. Rev. B58, 8596 (1998); H. Yamazaki et. al, J. Appl. Phys.81, 4706 (1997)., V. Grolier et al., J. Appl. Phys. 73, 5939(1993) .. and references therein.

Moreover, the claimed invention may involve a set of practical implementations for using the interface anisotropy as a way of neutralizing the undesirable effects of the easy-plane anisotropy originated from thin film shape. This may require not only the above mentioned understanding of the role of easy-plane anisotropy on spin-current threshold, and may also require not only the above mentioned (public domain) knowledge of the ability for Co/Au (and other materials combination's) interface to generate a component of perpendicular anisotropy, it may also require a realistic assessment of the materials compatibility between the manufacturing of a magnetic tunnel device – which involves the precise control of a very thin barrier structure down to 0.5 nm in total barrier thickness.

It also may require an understanding of the spin-transport characteristics of the materials involved – in this case that of cobalt and gold, the interface possesses the ability to generate a component of perpendicular anisotropy, and an interface that has a relatively weak spin-flip-

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scattering rate (compared to heavier elements such as Pt and Pd), that would result in better device integration – in terms of allowing both the generation of a perpendicular anisotropy component at the interface, and at the same time preserving enough spin-polarization for the action of spin-current-induced magnetic switching. This is a consideration behind the claimed invention which may involve a subset of materials combinations that are known in the open literature.

Because the claimed device is materially different from that of Hirai et al's, it is impossible for anyone skilled in the art to use the device invented by Hirai and making it thermally stable as suggested by Pakala.

Therefore, the claimed invention (e.g., claim 4) is not an obvious extension to the teachings of Pakala et al, or Hirai. Therefore, this rejection should be withdrawn.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

F. Iwasaki

The Examiner alleges that Hirai would have been combined with Iwasaki to form the invention of claim 6-7. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicant respectfully submits that these references are unrelated and would not have been combined as alleged by the Examiner. Thus, no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that there is no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, these references clearly do not teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, neither Harai, nor Iwasaki, nor any combination thereof teaches or suggests "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a*

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perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Iwasaki. In fact, nowhere does Iwasaki teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Iwasaki clearly does not teach or suggest the claimed invention.

Further, with respect to claims 6 and 7, we again note that the device of Hirai is a **magnetic-field-switched** memory. It is materially different from a spin-current switched device. The uniqueness of a spin-current switched device **does not follow from simple materials improvements** from the device of Hirai et al following the teachings of Iwasaki and Ikeda.

The fundamental limitation of a magnetic field-switched device is the requirement of generating sufficiently large a magnetic field on one selected bit element for a write operation, all the while (1) without disturbing a closely packed neighboring bit element, and (2) allowing the bit being written or the bit adjacent to be thermally stable over a period of time long enough for the memory to be considered nonvolatile. These are the limitations that a spin-current switched device may overcome. A spin-current device may be written by a localized current injection into the bit. It does not necessarily suffer the same disturbance concerns of a magnetic write process.

Therefore, without the teachings of a spin-current switched device as in the claimed invention, a person skilled in the art at the time of invention would not be able to merely improve Hirai's device to accomplish the function of a spin-current switched memory device. Therefore, this rejection should be withdrawn.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

G. Elliot

The Examiner alleges that Ikeda would have been combined with Elliot to form the invention of claim 11. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every

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element of the claimed invention.

Applicant respectfully submits that these references are unrelated and would not have been combined as alleged by the Examiner. Thus, no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that there is no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, these references clearly do not teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, neither Ikeda, nor Elliot, nor any combination thereof teaches or suggests "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Elliot. In fact, nowhere does Elliot teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Elliot clearly does not teach or suggest the claimed invention.

Further, the Examiner's rejection of claim 11 is based on devices relying on magnetic-field induced switching. Depending on the memory density, the magnetic-field switchable memory can have arbitrarily low current *density*. The differences to the claimed invention may include at least (1) the memory density itself has to be arbitrarily low, and (2) the current density referred to generally does not describe the current that passes through the memory element.

The claimed invention, as recited in claim 11, may be quantifying the current density of a spin-current switched device, which requires the spin-current related to the write operation to pass through the magnetic storage layer to be switched. This is materially different from the devices disclosed by Ikeda and the methodology discussed by Elliot.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

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H. Nakada

The Examiner alleges that Hirai would have been combined with Nakada to form the invention of claim 13. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicant respectfully submits that these references are unrelated and would not have been combined as alleged by the Examiner. Thus, no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that there is no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, these references clearly do not teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, neither Harai, nor Nakada, nor any combination thereof teaches or suggests "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Nakada. In fact, nowhere does Nakada teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Nakada clearly does not teach or suggest the claimed invention.

Again, the device disclosed by Ikeda is a magnetic-field switched device. Nakada's invention is a magnetic tunnel junction process for read-out operation. Neither inventions could be used, either separately or in combination, to allow a spin-current based "write" operation, which is what the claimed invention may involve. It is therefore impossible for a person skilled in the art to arrive at our invention based on the teachings of Ikeda and Nakada. Therefore, this rejection should be withdrawn.

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

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I. Inomata

The Examiner alleges that Chen would have been combined with Inomata to form the invention of claim 18. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicant respectfully submits that these references are unrelated and would not have been combined as alleged by the Examiner. Thus, no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that there is no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, these references clearly do not teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, neither Chen, nor Inomata, nor any combination thereof teaches or suggests "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Inomata. In fact, nowhere does Inomata teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus, Inomata clearly does not teach or suggest the claimed invention.

Applicant notes that the Examiner's rejection of claim 18 is that the device is similar to the device of Chen's. Actually, the Chen device is also a magnetic-field switched device. This is obvious from Chen's abstract, in the discussions, such as in column 2, lines 40-44 (the ways to reduce the magnetic field required for writing), as well as in Chen's claims (of a "low-switching field" device). The function of Chen's electric current is to generate a magnetic field that can be used to switch the device. The device disclosed by Chen is structurally as well as functionally different from that of ours disclosed in claim 18.

The claims of Inomata relates to a magnetic tunnel junction stack for the use of read-out. The stack can in principle contain multiple layers of barriers and magnetic layers, and it can be used to store multiple bits as discussed. However, this structure claimed by Inomata **does not use**

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spin-current to write the magnetic bits. The Inomata device is also one that relies on magnetic field for writing. This aspect of their device can be learned when examining figures 17,20, 22 where the agent that causes the magnetic switch (or resistance change which is a read-out of the magnetic state) is magnetic field – the magnetoresistance is plotted against applied magnetic field H on the horizontal axis.

Therefore, neither the Chen device, nor the teachings of Inomata would lead to the invention of a spin-current switchable junction stack as the claimed invention (e.g., claim 18).

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

J. Deak

The Examiner alleges that Chen would have been combined with Deak to form the invention of claim 19. Applicant submits, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicant respectfully submits that these references are unrelated and would not have been combined as alleged by the Examiner. Thus, no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant submits that there is no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, these references clearly do not teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, neither Chen, nor Deak, nor any combination thereof teaches or suggests "*a plurality of magnetic layers, at least one of said plurality of magnetic layers having a perpendicular magnetic anisotropy component and comprising a current-switchable magnetic moment*", as recited, for example, in claim 1 and similarly recited in claims 26 and 28.

Clearly, this feature is not taught or suggested in Deak. In fact, nowhere does Deak teach or suggest **at least one magnetic layer having a current-switchable magnetic moment**. Thus,

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Deak clearly does not teach or suggest the claimed invention.

Further, as noted above, the Chen device is structurally and materially different from our device. Similarly, the teaching of Deak is also about a pillar structure that needs to be **switched using a magnetic field**. This can be seen by examining Deak's figures 6, 7, and 8, where the important attribute is the magnetic field response of the pillar structure. This is also discussed in Deak's writings, for example, column 2, lines 22-24, column 4, lines 54-67, column 5, lines 1-2. Significantly, Deak's pillar does not use a spin-current to write that passes through the pillar. Therefore the device structure, as well as its function, is materially different from the claimed invention (e.g., claim 19).

Therefore, Applicant submits that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

III. FORMAL MATTERS AND CONCLUSION

The Examiner objects to the drawings as failing to show an embodiment of a memory cell in which the barrier layer is not in a magnetic pillar (e.g., see Application at page 9, lines 13-14). However, Applicant would point out that, contrary to the Examiner's assertions, 37 CFR §1.83(a) does not require that every feature disclosed in the specification be shown in a drawing. Indeed, 37 CFR 1.83(a) simply states that "[t]he drawing in a nonprovisional application must show every feature of the invention specified in the claims" (emphasis added).

Further, the Examiner surprisingly implies that a drawing showing a barrier layer "not in the magnetic pillar" is "essential for a proper understanding of the disclosed invention". However, Applicant would again point out to the Examiner that it is **only the claimed invention** with which the Examiner should be concerned. It is completely unreasonable for the Examiner to suggest that one of ordinary skill in the art could read the present Applications and not understand **the claimed invention** or understand how to make and use **the claimed invention**. That is, Applicant respectfully submits that one of ordinary skill in the art could read the present Application and readily understand how to make and use the **claimed invention**. Therefore, the Examiner is respectfully requested to withdraw this objection.

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The Examiner also objects to the drawings as not illustrating the feature recited in claim 12 (i.e., original claim 13). However, Applicant notes that a Replacement Drawing sheet for Figure 1F is submitted concurrently herewith, and corrects Figure 1F to clarify that leads 130 and 140 include magnetic layer 121 (e.g., see Application at page 12, lines 19-22). Therefore, the Examiner is respectfully requested to withdraw this objection.

Applicant notes that claim 17 has been amended to correct the spelling of "anisotropy". The Examiner is respectfully requested to withdraw this objection.

In view of the foregoing, Applicant submits that claims 1-30, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 50-0510.

Respectfully Submitted,

Date: 11/17/05



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CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that the foregoing was filed by facsimile with the United States Patent and Trademark Office, Examiner Thinh Nguyen, Group Art Unit # 2818 at fax number (571) 273-8300 this 17th day of November, 2005.



Phillip E. Miller
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